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POLLEN-TUBES AGAIN.

BY JOHN KRUTTSCHNITT, New Orleans, La.

[PLATE V.]

At last year's meeting of this Society, I presented a paper on the fecundation of ovules in Angiosperms, which was also published in the Proceedings.

The stand which I took was full of perplexities. It was said on one side that the entrance of the pollen-tube into the micropyle of the ovule was the easiest thing imaginable to demonstrate, whilst I, on the other had, after more than twenty years of patient labor and research, have, as yet, not been able to verify the fact. The mystery is now solved.

The most intolerant of my adversaries placed at my disposal a slide of *Capsella bursa-pastoris*, prepared by himself, accompanying it with notes and diagrams designating the spots where pollen-tubes could be seen. The object was prepared by tearing the ovary to pieces, of which the stigma formed one, and the ovary and ovules several other fragments. I easily found the marked spots, but no pollen-tubes. In one instance my attention was called to a certain spot, where it was stated that the "pollen-tubes had pierced the placenta." I discovered here only the stump of a torn-off funiculus, with traces of fibers of the conducting tissue; and again, in another place near a spiral fiber, which he indicated, the traces of some other fiber—but again no pollen-tubes.

The scalpel and needle seem to be generally employed in searching after pollen-tubes. Dr. Carpenter, in his book, "The Microscope and Its Revelations," recommends their use, and so does Mr. Strasburger, in a letter written to me in 1883. I followed this mode at first, but I abandoned it when I found that it produced only erroneous results, inasmuch as the continuity of the tissues are thus

EXPLANATION OF THE FIGURES.

FIG. 1.—Transverse section of ovary of *Cereus Grandiflora.*

a. Micropyle. *b.* Ovule. *c.* Funiculus. *d.* Papillæ on the ventral portion of the funiculus. *e.* Vascular fibre.

FIG. 2.—Apex of one of the lobes of the stigma.

a. Pollen-grains discharging their contents, *b.* *c.* Papillæ on the stigma. *d.* Spiral fibre.

FIG. 3.—Conducting tissue extracted from the style some distance from the stigma.

FIG. 4.—Pollen-grains of a lily in dammar.

FIG. 5.—Pollen-grains in gum arabic dissolved in glycerine. In the former the contents of the pollen-grains are apparently not discharged; the longitudinal markings I consider to be the folds of the shrunken membrane of the pollen-grain, the globules are considerably refractive. In figure 5 the contents of the pollen-grain are discharged through the longitudinal fissure in highly refractive globules of an oily appearance, and scattered over the field of view of the microscope.

PLATE V.

Fig. 1
X 500

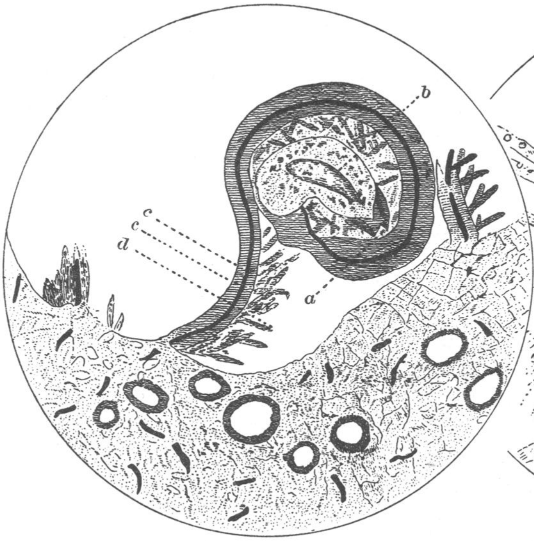
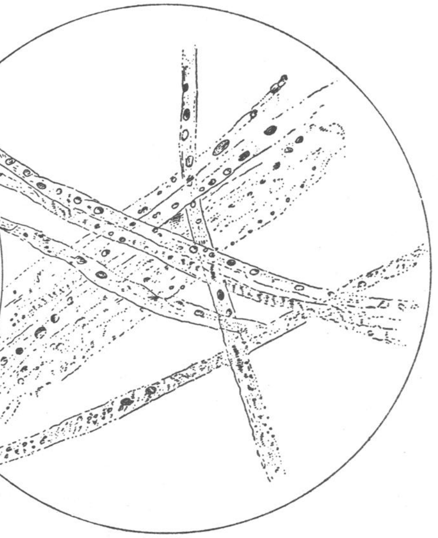


Fig. 3
X 500



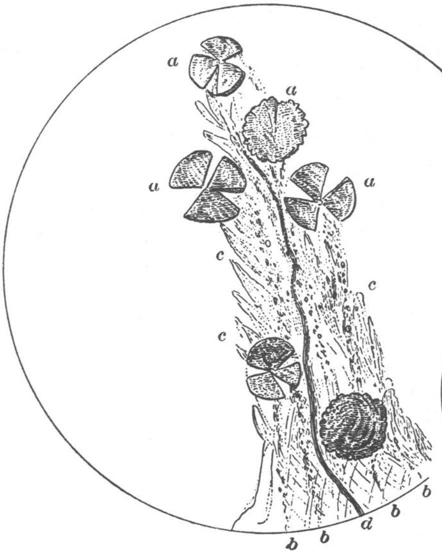


Fig. 2
X 250

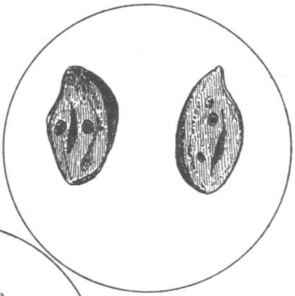


Fig. 5
X 250

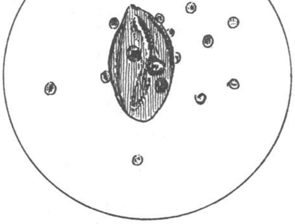


Fig. 4
X 250

destroyed, and it would be strange if, in the process of tearing the ovary, some fibers of the conducting tissue should not be found in contact with the micropyle of an ovule.

The investigators, in their search for separate pollen-tubes, have evidently mistaken the fibrillæ of the conducting tissues for them. According to my opinion these fulfill, in fact, the task attributed to pollen-tubes, inasmuch as they are charged with the fertilizing element contained in the pollen-grain. The discrepancy in the results obtained must be attributed to the different modes of preparation employed and to the fertility of the imagination of the observer.

Mr. Strasburger has recently published a "New Investigation of the Fertilization of the Phænemogam's"—investigations which I believe he was induced to undertake by the correspondence which I exchanged with him in 1883. I make the following translation from what he says on *Cereus:* "The pollen-tubes, after treatment with an iodine solution, appear so singularly distinct that even *Cereus* may be recommended as a very good object in which to trace the pollen-tubes in the style. The penetration of the pollen-tubes into the tissues of the stigma of *Cereus* is not easy to follow in their individuality (in den Einzelheiten), but this may very easily be done with *Gramineæ* and *Cyperaceæ.* In *Cereus* the emptied portion of the pollen-tubes becomes so strongly collapsed, and the membranes are so delicate, that it is quite difficult to differentiate them. The pollen-tubes make their descent into the tissues surrounding the stylar canal and not through the canal itself, although such a canal exists."

Mr. Strasburger followed the pollen-tubes into the style only, but did not pursue them further down into the ovary and to the micropyle. He does not say a word about the finely granular matter found in such extraordinary profusion in the conducting tissues of the style, and to some extent in the papillæ on the funiculi of the ovules—and this, notwithstanding that I particularly called his attention to these points in one of my letters in the correspondence heretofore alluded to. He evidently fails to appreciate the significance of the conducting tissue and its functions. I apprehend that if he had done so he would have invalidated his arguments in favor of the existence of separate pollen-tubes.

I have recently repeated my observations on the ovaries of a cactus (*Phyllocactus phyllanthus*) at different stages of the development of the flowers, which are very large. In one of its earlier stages the conducting tissue is easily distinguishable in the style surrounding the stylar canal, which becomes obliterated (or nearly so) near the apex of the ovary. The many lobes of the stigma are very well developed, the ovules are partly so, and the anthers are full of pollen-grains, almost of the same size as in the mature state. In a flower which in a few hours later would have opened, I found pollen-grains adhering to the lobes of the stigma, which, however, disappeared on further manipulation. Some fovilla granules were found in the conducting tissue of the style. I allowed a third flower to expand fully. The pollen-grains adhered strongly to the lobes of the stigma, and, in tearing them away from the style, portions of the conducting tissue came off with them. In these portions the fovilla was seen in cloudy specks and particles, and, by extracting the tissue from the style, the fovilla may be followed down to the apex of the ovary, where it appears to be evenly distributed. The conducting tissue may easily be separated in single fibrillæ, which are tubular, and which, being charged with the fertilizing element of the pollen, may not improperly be called pollen-tubes. In effect, according to my views, by diffusing the fertilizing element over the entire inner structure of the ovary, they perform the functions of the so-called pollen-tubes.

The ovary of *Cereus* contains, according to my computation, at least 3,000 ovules, each of which, it is said, must be fertilized by a separate tube. It accordingly requires 3,000 pollen-tubes to make their descent through the style, and this mass of foreign element in the style—which already contains as much of its normal tissue as it can hold, should be easily discovered. It would also seem as though some of the numerous tubes should be found in the ovary sticking in the micropyle of the ovule. I have, however, thus far not been able to discover anything of the kind.

The process of fertilization in the *Cactaceæ* may readily be demonstrated and made comprehensible to any unbiased mind. In examining a transverse section of *Cereus* many ovules will be seen swinging on their long funiculi, covered on their ventral portion with many minute papillæ, with which the micropyle of the ovules is brought into natural contact by simply bending over. The papillæ contain granular matter, such as is found in the conducting tissue, which is the fertilizing element of the pollen, and thus the fertilization is accomplished without the help of pollen-tubes.

If the functions which nature has designed for the conducting tissue were accorded to it, the difference between the views which I entertain, and which have been so indignantly denounced by some of the American professors of botany, and the teachings of these professors themselves, would be narrowed down to very small limits. The fibers of the conducting tissue would then, perhaps, be allowed to take the place of pollen-tubes, whose functions, as I have said, I believe that they perform. The former carry the fertilizing element said to be contained in the latter, minus the mysterious pollen-grain nucleus, which is said to occupy the extremity of the pollen-tube, and to the description of the nature and functions of which Mr. Strasburger devotes thirty-four pages of his book.

In the treatment of the pollen-tube question I have now found out that new ideas, not in harmony with established text-books of any science, have a very poor show of finding favor with the professors of that science. It would be an act of self-destruction for any one who aspires to a professorship to proclaim them. If one should do so he would be proclaimed a heretic, and voted out of the congregation. This is the reason why erroneous theories are so difficult to eradicate. Free discussion is not even tolerated. The pollen-tube question furnishes an example. One who has written a book cannot be expected to spoil its sale by proclaiming its errors. As I do not intend writing a book or aspiring to a professorship I have nothing to lose, and I shall, therefore, continue the battle, even should I remain single-handed.